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(54) Abstract Title: **Multi-channel tuner**

(57) A multi-channel tuner apparatus which is capable of simultaneously and independently selecting a plurality of channels for reception comprises a plurality of tuners (5), each of which converts a selected channel to a near-zero intermediate frequency. The output signals from the tuners are supplied to respective sample/hold circuits (30,31), whose outputs are supplied to a single analogue/digital converter (33) for multiplexing the tuner signals and converting them to the digital domain. A common demodulator arrangement (35, 36) processes the digital domain signal to extract the information from all of the selected channels.

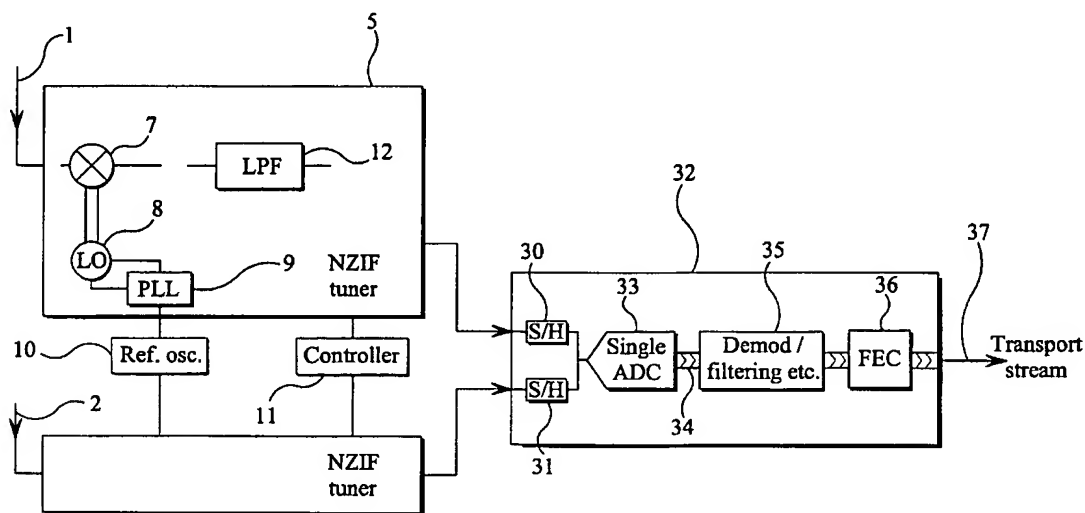


FIG 2

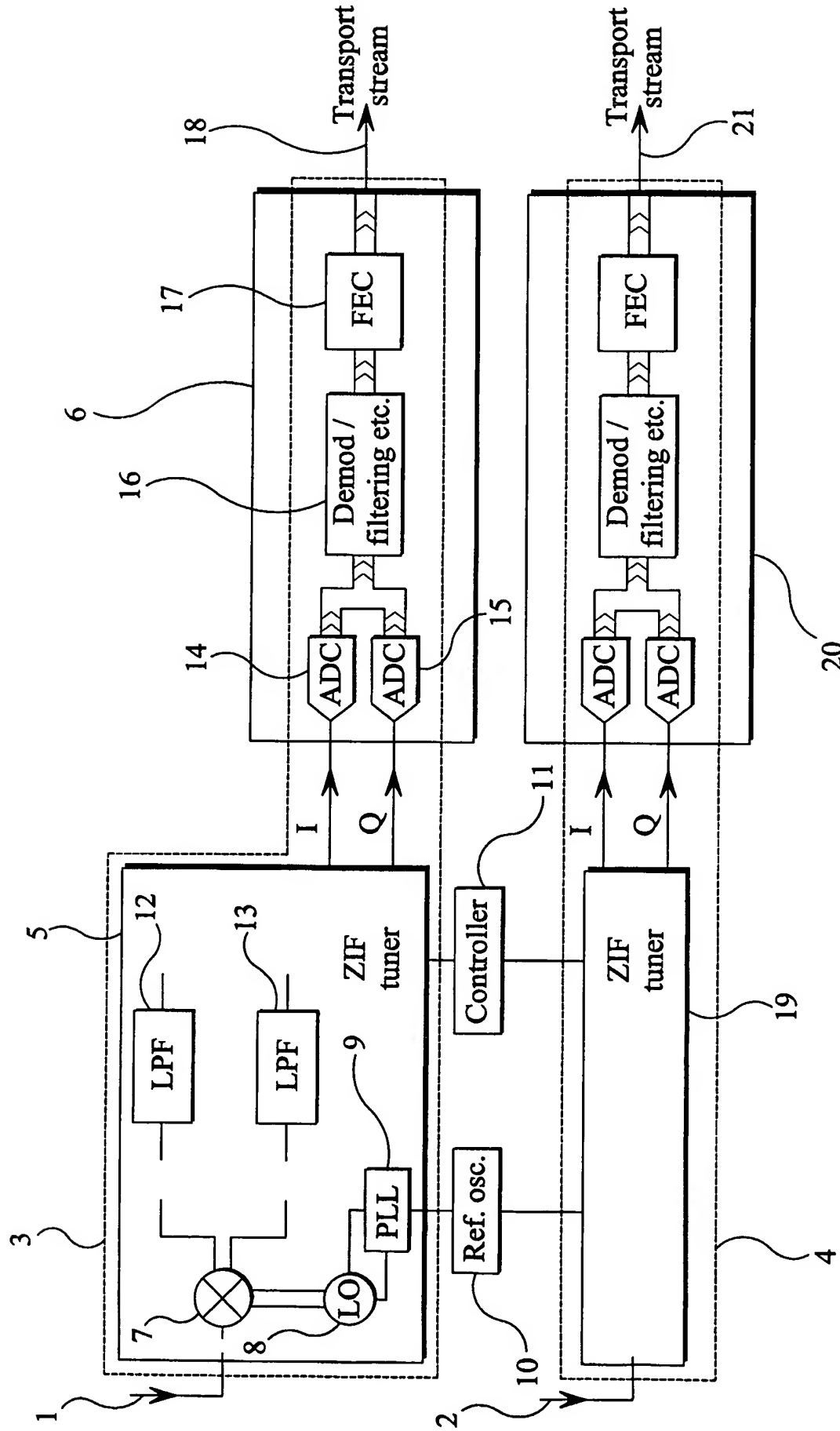


FIG. 1

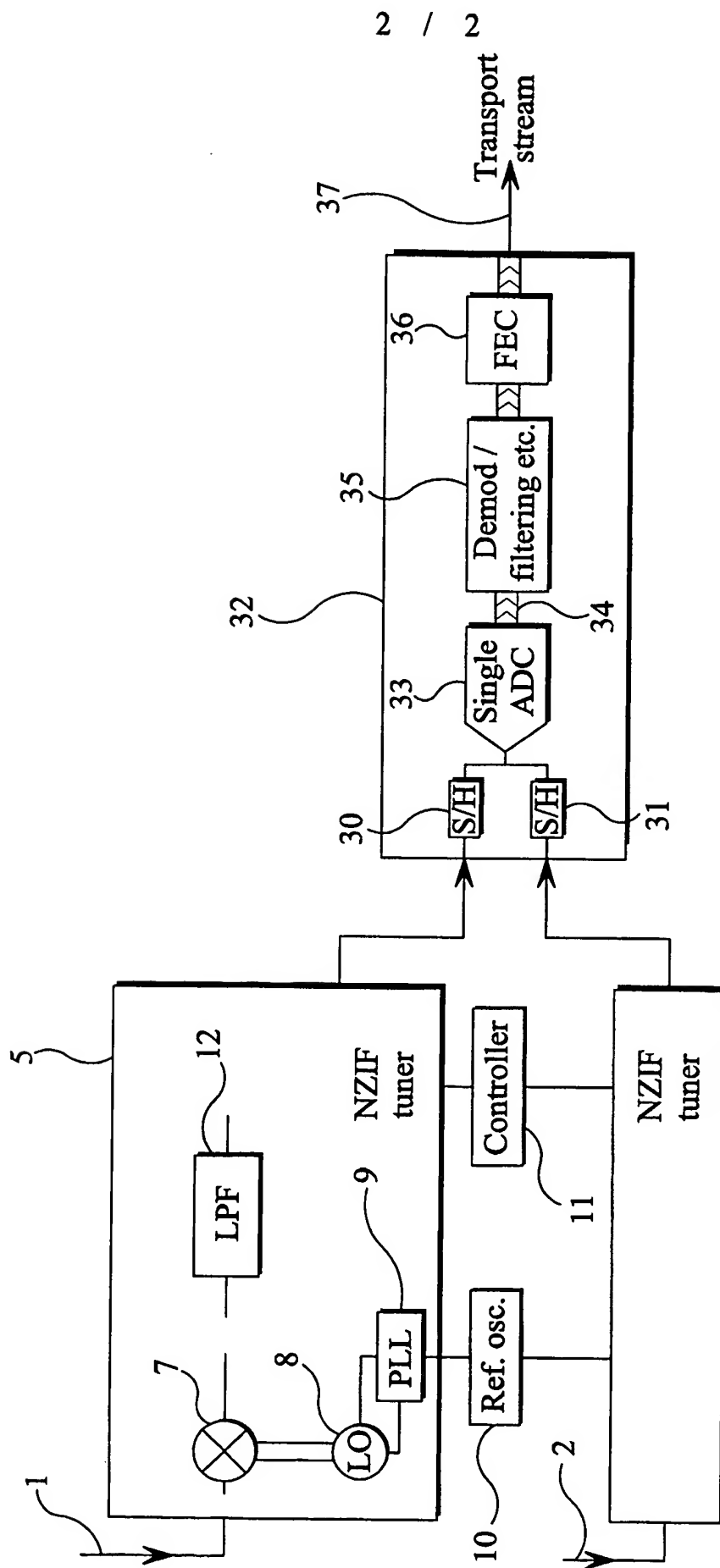


FIG. 2

MULTI-CHANNEL TUNER APPARATUS

The present invention relates to a multi-channel tuner apparatus for simultaneously and
5 independently selecting a plurality of channels for reception. Such an arrangement may
be used, for example, for digital satellite broadcast signals, terrestrial broadcast signals
and cable distribution systems.

It is known for satellite set-top box arrangements to provide multi-channel reception
10 capability, for example for PVR (personal video recorder) type applications. For such
applications, each channel must be receivable independently of each other channel
selected for reception. This is particularly important in satellite applications because the
signal received from an outdoor unit covers a wider frequency range than the operating
range of a typical set-top box and contains two polarisations which effectively overlap.
15 To accommodate this, it is known to have one or two cable feeds from the outdoor unit
to the set-top box, each of which can potentially carry any channel from the spectrum of
a received signal.

Figure 1 of the accompanying drawings illustrates a typical multi-channel tuner
20 arrangement for such an application. The cable feeds are shown at 1 and 2 and are
connected to independent signal paths 3 and 4, respectively, although a single cable feed
connected to both signal paths may also be used. The signal paths are substantially
identical so that only the path 3 is shown and will be described in detail.

25 The signal path 3 comprises a zero intermediate frequency (ZIF) tuner 5 connected to a
demodulator arrangement 6. The tuner 5 comprises a quadrature mixer 7, which
receives a broadband input signal from the cable feed 1 directly or via other stages (not
shown), such as a low noise amplifier and an automatic gain control arrangement. The
mixer 7 receives quadrature signals from a local oscillator (LO) 8 controlled by a phase
30 locked loop (PLL) synthesiser 9. The PLL 9 receives a reference frequency signal from
a reference oscillator 10, which is common to both of the tuners, although independent
reference oscillators could alternatively be provided.

Tuner operation is controlled by a common controller 11, which could also be replaced by separate controllers for the individual tuners. The synthesiser 9 is controlled in accordance with a request from a user for reception of a selected channel. The synthesiser 9 controls the oscillator 8 to provide quadrature signals whose frequency is substantially equal to the centre frequency of the channel selected for reception. The mixer 7 converts the selected channel to in-phase I and quadrature Q baseband signals centred around 0 Hz.

The signals I and Q are supplied to respective low pass filters (LPF) 12 and 13, which filter the baseband signals so as to attenuate or remove signal energy from non-selected channels. The filters 12 and 13 may be connected directly to the mixer 7 or via other stages (not shown), such as amplifiers and automatic gain control arrangements. Similarly, the output signals of the filters 12 and 13 may be supplied directly to the tuner outputs or may be supplied via other stages (not shown), such as amplifiers and automatic gain control arrangements.

The filtered I and Q signals from the tuner 5 are supplied to respective analogue/digital converters (ADC) 14 and 15, which sample the quadrature components and convert them to respective independent data streams. The data streams are supplied to a demodulator block 16, which typically filters, fine tunes, and demodulates the received quadrature signal. The demodulated signals are then supplied to a forward error correction (FEC) block 17, which performs the appropriate error correction in accordance with the modulation standard of the received channel. The block 17 supplies the output signal at an output 18 of the tuner arrangement.

The broadband signals supplied via the cable feed 2 are likewise processed by the second ZIF tuner 19 and the second demodulator arrangement 20 and the resulting signals appear at a second tuner arrangement output 21 as a separate transport stream. Each of the transport streams may be parallel or analogue or the streams may be multiplexed together. Although only two signal paths 3 and 4 are shown, any number of such paths may be provided according to application requirements.

Although such an arrangement functions satisfactorily, it is relatively complex and expensive. In particular, most or all of the individual functions have to be duplicated or multiplied.

- 5 Accordingly to the invention, there is provided a multi-channel tuner apparatus for simultaneously and independently selecting a plurality of channels for reception, comprising: a plurality of tuners, each of which is arranged to convert a selected channel to a near-zero intermediate frequency; a respective sample/hold circuit for sampling the near-zero intermediate frequency output signal of each channel; a single
10 analogue/digital converter for converting the output signals of all of the sample/hold signals to a single digital signal; and a demodulator arrangement for processing the digital signal to extract the information from all of the selected channels.

The plurality of tuners may comprise two tuners.

15

Each of the tuners may comprise an image reject mixer.

The converter may be arranged to receive samples from the sample/hold circuits in turn.

- 20 Each of the tuners may comprise a single intermediate frequency filter. Each of the intermediate frequency filters may comprise a low pass filter.

Each of the tuners may comprise a local oscillator which is tuneable to a frequency above and adjacent the centre frequency of the selected channel.

25

The tuners may be substantially identical to each other.

The demodulator arrangement may be arranged to perform quadrature signal extraction.

- 30 It is thus possible to provide an apparatus which is of reduced complexity and reduced cost of manufacture compared with known arrangements. For example, when embodied as one or more integrated circuits, less area is required so that a more cost-effective arrangement can be provided.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which;

5 Figure 1 is a block schematic diagram of a known multi-channel tuner arrangement; and

Figure 2 is a block schematic diagram of a multi-channel tuner apparatus constituting an embodiment of the invention.

10 Like reference numerals refer to like parts throughout the drawings.

The multi-channel tuner apparatus shown in Figure 2 comprises a two channel arrangement, but more than two channels may be provided in accordance with the specific application. The apparatus comprises a common reference oscillator 10 and a
15 common controller 11 of the same type as shown in Figure 1 although, again, separate reference oscillators and controllers could be provided for each tuner 5.

The tuner 5 shown in Figure 2 differs from that shown in Figure 1 in that it is a near-zero intermediate frequency (NZIF) tuner. Further, the mixer 7 is an image reject
20 mixer. The controller 11 controls the synthesiser 9 in accordance with selection by a user of a desired channel for reception from the broadband signal supplied via the cable feed 1. The synthesiser 9 controls the local oscillator 8 such that its frequency is adjacent but slightly above the centre frequency of the selected channel. The mixer 7
25 thus converts the selected channel to an NZIF signal supplied at the single output of the mixer 7. Thus, the frequency content of the NZIF signal is maintained and this allows for quadrature component extraction at a later stage of the apparatus.

Whereas the ZIF mixer 7 in Figure 1 separates the I and Q signals which thus require separate filtering, the mixer 7 of Figure 2 provides a single output signal. Thus, only a
30 single low pass filter 12 is required in the tuner 5.

The output signals from the tuners 5 and 19 are supplied to respective sample/hold circuits 30 and 31, respectively, in a single demodulator arrangement 32. The samples

supplied by the circuits 30 and 31 are alternately converted to the digital domain by a single analogue/digital converter (ADC) 33 so that the channels selected by the tuners 5 and 19 are multiplexed to a single data stream at the output 34 of the ADC 33. The resulting multiplexed digital signal is then processed by a demodulator block 35 and a forward error correction (FEC) block 36, before being supplied to the output 37 of the apparatus as a transport stream containing the demodulated and error-corrected information in digital form from the two selected channels. The block 35 performs the quadrature component extraction in addition to the filtering and demodulation required by the modulation standard. The multiplexed channel signals are processed by common blocks 35 and 36 in accordance with known techniques which have little penalty in terms of complexity and cost of manufacture.

The apparatus shown in Figure 2 is thus less complex and requires less integrated circuit space than the known arrangement shown in Figure 1. For example, the four ADCs in Figure 1 are replaced by a single ADC and a dual sample/hold arrangement. Also, the four intermediate frequency filters of Figure 1 are replaced by two intermediate frequency filters. Further, the pairs of demodulation and error correction blocks of Figure 1 are replaced by single blocks. The apparatus of Figure 2 therefore has substantial design, manufacture and cost advantages compared with the arrangement of Figure 1 while providing satisfactory performance.

CLAIMS:

1. A multi-channel tuner apparatus for simultaneously and independently selecting a plurality of channels for reception, comprising: a plurality of tuners, each of which is
5 arranged to convert a selected channel to a near-zero intermediate frequency; a respective sample/hold circuit for sampling the near-zero intermediate frequency output signal of each channel; a single analog/digital converter for converting the output signals of all of the sample/hold circuits to a single digital signal; and a demodulator arrangement for processing the digital signal to extract the information from all of the
10 selected channels.
2. An apparatus as claimed in claim 1, in which the plurality of tuners comprises two tuners.
- 15 3. An apparatus as claimed in claim 1 or 2, in which each of the tuners comprises an image reject mixer.
4. An apparatus as claimed in any one of the preceding claims, in which the converter is arranged to receive samples from the sample/hold circuits in turn.
20
5. An apparatus as claimed in any one of the preceding claims, in which each of the tuners comprises a single intermediate frequency filter.
6. An apparatus as claimed in claim 5, in which each of the intermediate frequency
25 filters comprises a low pass filter.
7. An apparatus as claimed in any one of the preceding claims, in which each of the tuners comprises a local oscillator which is tuneable to a frequency above and adjacent the centre frequency of the selected channel.
30
8. An apparatus as claimed in any one of the preceding claims, in which the tuners are substantially identical to each other.

9 An apparatus as claimed in any one of the preceding claims, in which the demodulator arrangement is arranged to perform quadrature signal extraction.



INVESTOR IN PEOPLE

Application No: GB 0229971.7
Claims searched: 1 to 9

Examiner: John Donaldson
Date of search: 13 May 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	GB 2372162 A (ZARLINK), see abstract

Categories:

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art
Y Document indicating lack of inventive step if combined with one or more other documents of same category	P Document published on or after the declared priority date but before the filing date of this invention
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^v:

H3R

Worldwide search of patent documents classified in the following areas of the IPC⁷

H03D

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO